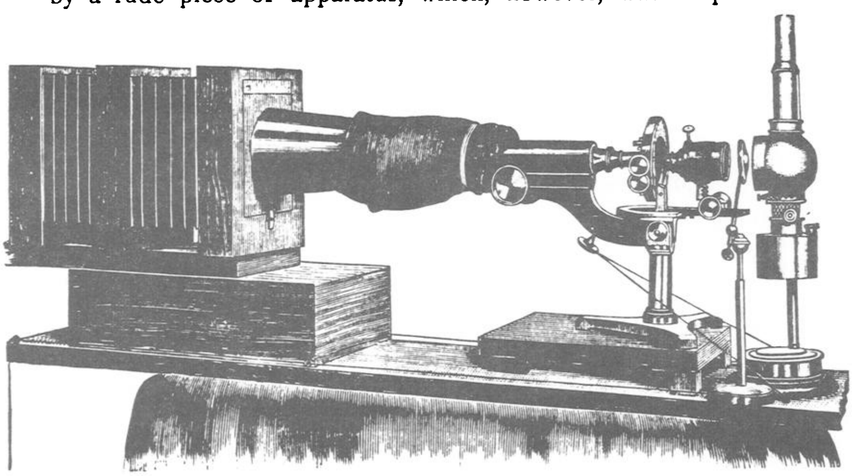
Photo-Micrography with Dry-Plates and Lamp-Light.

By W. H. Walmsley, F. R. M. S., Philadelphia, Pa.

At the Elmira meeting of this society, in 1882, I had the honor of reading a short paper on the subject of "Photo-Micrography, with Gelatine Dry-Plates and Lamp-Light." This paper was illustrated by a rude piece of apparatus, which, however, was of practical



working value, and a negative was made at the time, which, unfortunately, came to naught, through the worthlessness of the developer used. I stated at the time that the germ of a useful addition to our microscopical accessions seemed to exist in this arrangement, and expressed the hope that it would be worked out by others with more leisure and ability than was possessed by myself. I am pleased to know that this has been done in various directions, and I have had

most creditable specimens of work sent me by those who have only taken up the subject within the past year. My own work in this direction, which has been limited by the unceasing demands of an active business upon my time, has been directed to perfecting the manipulation of the apparatus, and the determination of the kinds of dry plates best adapted to the work, together with the average exposures required. A fair degree of success has attended these efforts, though much more remains to be done, and I submit the aparatus now shown as a substantial advance upon that exhibited at Elmira.

A removable, conical tube attached to the front of the camera materially increases the length of the same without adding to its bulk, as greater length of bellows would do. The fine adjustment is readily controlled from the extreme rear of the bellows, holding the focusing-glass, by a very simple arrangement. A groove is turned in the periphery of the milled head, moving the fine adjustment around, while a strong, fine cord is passed, and the ends carried through a succession of screw-eyes attached to the base-board, to the end thereof, where a couple of small leaden weights serve to keep the cord stretched tightly. The slightest pull upon this cord on either side serves to change the adjustment in the most delicate manner. A fine fishing-line is the best cord for this purpose that I have tried, and the arrangement is appliable alike to microscopes, having the fine adjustment at the rear of the limb, or on the nose-piece of the compound body. No surface of ordinary ground glass is delicate enough for the accurate focusing of any but the lowest powers. I therefore make use of it only to arrange the illumination evenly and to center the object properly. These important preliminaries settled, I remove the ground glass screen and replace it with the plate-holder, from which front and back have been removed and a sheet of glass inserted in the position, afterward to be occupied by the sensitized plate. No image can now be seen with the naked eye, but if a properly constructed focusing-glass be placed against the part of the plate and the eye applied thereto, the object can be distinctly seen, and accurately focused by the cord arrangement before described. A glass by Dariot, made for this purpose, is recommended, but it is somewhat expensive. An ordinary three-

legged microscope, with screw adjustment of focus, will answer very well. Either of these instruments should be previously adjusted to focus accurately upon the opposite surface of the glass plate, against which it is placed, and then secured in this position for future use. Actual experiment has shown that the chemical and visual foci of the objectives, when used for photographing by lamp-light, are practically co-equal, and it has not been found necessary to employ those specially corrected for this purpose. The Messrs. Beck have recently made for me a set of objectives corrected by the addition of a double convex posterior lens, which adds but a trifle to their cost, and which is removable when the lenses are employed for ordinary investigations. The performance of these objectives is very fine; a little better certainly than that of the uncorrected ones, but the latter work so well that no one need be deterred from using them for photographic work. For powers above half an inch it may be most certainly said that no special correction is at all necessary. My experiments of the past year have clearly shown that there is no practical limit to the powers that may be used on the score of illumination. A good lamp, with achromatic condenser on the microscope, will afford ample light for the employment of a one-twentieth. The highest power I have used was a one-tenth with amplifier, with which I obtained most excellent negatives, whilst a medical friend in Philadelphia, who has turned his attention to the subject within a few months, is using a one-sixteenth habitually with entire success. With such gelatine plates as are now obtainable, there is no more difficulty in securing negatives, with the necessary qualities of sharpness and density, when employing such powers, than with a half inch if the proper exposure be given. There is much less difficulty in determining the proper length of exposure than the landscape photographer encounters, since there is no variation of the light to judge about, and the actinic properties of various tissues and staining fluids are quickly learned from a few experiments. Indeed, so uniform are these conditions when certain brands of plates are used, that I have no hesitation in giving the following table of exposures as a reliable guide to the novice in photo-micography:

One and a half inch objective, 2 to 3 minutes.

Two-third inch objective, 3 to 4 minutes.

Four-tenths inch objective, 7 to 10 minutes.
One-fifth inch objective, 8 to 12 minutes.
One-tenth inch objective, 12 to 15 minutes.
One-sixteenth inch objective, 15 to 20 minutes.

From careful experimentation with nearly all the brands of plates in the market, I have found that the three known respectively as Carbutt's "Special," Eastman's "Rapid," and Beebe give the best results, being very uniform in their behavior, extremely sensitive, and developing with the density so necessary in a negative of this class. Other makes have yielded good results in my hands, out in all desirable qualities either of those specially named leave nothing to be desired.

Either ferrous oxalate or pyrogallic acid developers may be used with equal success for most classes of subjects, the former giving the best results with diatoms, or any object in which the markings are sharp and decidedly defined, while the latter yields softer prints of most animal and vegetable tissues, in which the differentiation of the various vessels, cells, etc, is less distinctly marked. If the ferrous oxalate be employed, the oxalate solution should be made decidedly acid with citric or oxalic acids, and the developer strong and active—four parts of oxalate to one of iron. A vast number of formulæ for "pyro" developers have been published, all of which are doubtless useful. The following I have found to be the best for developing negatives of microscopic objects, with either of the makes of plates specially named: Make two stock solutions, either of which will keep for a long while: No. 1, Pyrogallic acid, ½ ounce; alcohol, 2 ounces; No. 2, water, 30 ounces; bromide of ammonium, 30 grains; strong liquor ammonia, 1 dram. To use, take of No. 2 2½ ounces and add to it immediately before using 15 drops (¼ dram) of No. 1, which will be sufficient to develop a single plate. Two or even three plates may be developed with the one mixture, but to insure the best and cleanest results I would recommend employing a fresh one for each negative. If the exposure and subsequent development have been correct, the negative will almost invariably be found to possess sufficient density without subsequent intensification; if, however, the latter has to be resorted to, the cyanide of silver is recommended as being the best with which I am acquainted, and entirely satisfactory in its results.

The ready sensitized paper, which can now be procured of all dealers in photographic supplies, yields most excellent and brilliant prints, with no trouble in the preliminary silvering, and its use is highly recommended. Care should be taken not to print too deeply lest delicate markings be lost. Print on sheets 4½x5½ inches, of which sixteen may be cut from a single large sheet as purchased, and use a mat of non-actinic paper, from which a circle 2¾ inches in diameter has been cut. This will leave a clean-cut print of that size with a clean white margin of the proper dimensions to cover a card of cabinet size, which is pleasing in form and convenient for handling. The old favorite acetate of soda bath is recommended most highly for the toning, as it yields brilliant prints of pleasing tone, and may be used over and over again, improving with age. If it is desirable to make a fresh bath each time, the following will be found most excellent: chloride of gold, 1 grain; phosphate of soda, 20 grains; water, 2 ounces; adding a pinch of table salt. This bath is sufficient to tone a whole sheet of paper 18x22 inches, giving brilliant purple tints. It will not keep, and must be made fresh every time it is needed for use. The prints should be attached to the card-mounts by good starch or parlor-paste, brushed lightly over their backs while damp. Subsequent burnishing will greatly improve their appearance and render the delicate markings more distinct.

For lantern transparencies, contact printing, using a very slow plate, like Carbutt's A plates by lamplight, followed by rapid development with a strongly acid ferrous oxalate solution, will be found to yield most satisfactory results. The development must not be prolonged lest too great density in the shadows and smokiness in the clear lights be the result. If the operations be carefully managed, the results will be quite as satisfactory as those obtainable by any other process.

Finally, I would say that, from recent experiments, I am satisfied that it is quite as feasible to photograph opaque microscopic objects as transparent ones, with power, at least, up to a half-inch. My work in this direction has been so recent and so limited that I cannot at present give any exact data respecting the manipulations, exposures, etc., but I have done enough to be able to state positively that any object which will reflect light at all may be photographed with

powers from the lowest up to a half-inch, if illuminated by sunlight reflected upon it by a silver mirror, and with exposures varying from one second to twenty. I hope during the coming year to be able to carry on the experiments to more definite conclusions, and that other workers may be induced to follow out the same line of experiment.